

CHAPTER 3. MARKET AND TECHNOLOGY ASSESSMENT

TABLE OF CONTENTS

3.1	INTRODUCTION	3-1
3.2	PRODUCT CLASSES	3-1
3.3	MANUFACTURERS AND MARKET SHARES	3-1
3.4	HISTORICAL SHIPMENTS	3-2
3.5	RETAILERS	3-5
3.6	PRICE DISTRIBUTION	3-6
3.7	PRODUCT CHARACTERISTICS	3-9
3.8	MARKET SATURATION	3-12
3.9	VOLUNTARY PROGRAMS (TO INCREASE WASHER EFFICIENCY / PROMOTE HORIZONTAL AXIS MACHINES)	3-13
3.10	FUEL USE	3-13
3.11	INDUSTRY COST STRUCTURE	3-15
3.12	INVENTORY LEVELS AND CAPACITY UTILIZATION RATES	3-17
3.13	TECHNOLOGY ASSESSMENT	3-18
3.14	ENERGY EFFICIENCY	3-18
3.15	DETERMINING MEF VALUES FOR VERTICAL AXIS COMPACT CLOTHES WASHERS	3-19

LIST OF TABLES

Table 3.1	Market Shares (%) and Consolidation in the Washer Industry, 1977-1998	3-2
Table 3.2	Number of Establishments in Household Laundry Equipment (SIC 3633)	3-2
Table 3.3	Industry Unit Shipments	3-3
Table 3.4	Washer Shipments by Access	3-4
Table 3.5	Washer Sales by Type of Outlet	3-5
Table 3.6	Clothes Washer Unit Sales by Price Range	3-6
Table 3.7	Producer Price Index, Annual Average (1982=100)	3-7
Table 3.8	Consumer Price Index (All Urban Consumers); Annual Average (1982-1984 = 100)	3-8
Table 3.9	Washer Characteristics (1995)	3-9
Table 3.10	Brand Names, Price Level and Market Share of Major Manufacturers	3-11
Table 3.11	Washer Market Share by Brand	3-12
Table 3.12	Market Saturation by Fuel Type Among Housing Units with Clothes Washers	3-14
Table 3.13	Employment and Earnings	3-15
Table 3.14	Information from the 1992 and 1997 Census of Manufactures	3-15
Table 3.15	Summary of SEC 10-K Reports of Appliance Manufacturers	3-16
Table 3.16	End-of-year Inventory, 1977-1997	3-17
Table 3.17	Full Production Capacity Utilization Rates* (%)	3-17

Table 3.18	Product Characteristics of Clothes Washer Tested	3-18
Table 3.19	Summary of Appendix J and J1 Test Results	3-19
Table 3.20	Estimated MEF Values for 1.56 and 1.96 Cubic foot Clothes Washers	3-20

LIST OF FIGURES

Figure 3.1	Washer Market Share by Type, 1998	3-4
Figure 3.2	Producer Price Index for All Commodities and for Laundry Equipment, 1967-1998	3-7
Figure 3.3	Consumer Price Index for All Items and for Laundry Equipment, 1982-1999 .	3-8
Figure 3.4	Washing Machine Market Share by Cubic Capacity	3-10
Figure 3.5	Washing Machine Market Shares by Speed	3-10
Figure 3.6	Clothes Washer Saturation Rates (% of Household Units)	3-13
Figure 3.7	Water Heater and Dryer Fuel Use	3-14
Figure 3.8	Washing Machine Industry Cost Structure as a Percentage of Revenues	3-16

CHAPTER 3. MARKET AND TECHNOLOGY ASSESSMENT

3.1 INTRODUCTION

This chapter provides a profile of the clothes washer industry in the United States. The preliminary market and technology assessment presented in this chapter is developed from publicly available information. This information is helpful in identifying the major manufacturers and their product characteristics which form the basis for the engineering and the life-cycle-cost analysis. Present and past industry structure and industry financial information help the Department in the process of conducting the manufacturer impact analysis.

3.2 PRODUCT CLASSES

The Association of Home Appliance Manufacturers (AHAM) defines a compact washer as “Combination of cabinet width of 24 inches or less and a washer tub capacity of less than 2.0 cubic feet and/or a dryer drum capacity of less than 4.4 cubic feet”.¹ This definition is different than DOE’s definition of a compact washer which is a washer with a capacity of less than 1.6 cu. ft.. Using the AHAM definition, Appliance Magazine Statistical Review shows for 1995 compact washer sales accounted for 2.8% (200,000) of the total residential washer market.² For the year 1996, washer imports were 2.3% of domestic sales. Imports tend to be compact horizontal axis machines (H-axis).³

3.3 MANUFACTURERS AND MARKET SHARES

As reported in Appliance Magazine, there are five major manufacturers of clothes washers in the United States. Their market shares have remained fairly steady in the last seven years, as can be seen from Table 3.1. Each manufacturer offers multiple brand names. Some of the brand names come from independent appliance manufacturers which have been acquired over time. Table 3.2 shows that the number of household laundry equipment manufacturers, as reported in the U.S. Census of Manufactures, has also been relatively constant in the past 10 years.

Table 3.1 Market Shares (%) and Consolidation in the Washer Industry, 1977-1998

Manufacturer	1977	1982	1990	1998
Whirlpool	45	41	51	53
General Electric	20	20	16	15
White Consolidated	*	14 (bought Frigidaire in 1979)	*	*
Electrolux	*	*	12 (bought White Consolidated in 1986)	7
Magic Chef	*	5	*	*
Maytag	15	15	18 (bought Magic Chef in 1986)	21
Raytheon/ Goodman	*	*	3	4

* Insignificant market share or no production

Source: Share-of-Market Picture for (year), *Appliance Magazine*, September 1978, 1983, 1991, 1999.⁴

Table 3.2. Number of Establishments in Household Laundry Equipment (SIC 3633)

	Firms entering (+); Firms exiting (-)							
	1963	1967	1972	1977	1982	1987	1992	1997
All establishments	39	35(-4)	29 (-6)	31 (+2)	25 (-6)	18 (-7)	17 (-1)	17
Establishments with 20 or more employees	28	28	24 (-4)	24	20 (-4)	16 (-4)	15 (-1)	15

Source: U.S. Bureau of the Census, *Census of Manufactures*, 1977, 1992, 1997.⁵

3.4 HISTORICAL SHIPMENTS

Clothes washer shipments in the U.S. have been increasing at an average rate of 2.15% over the last 10 years. Table 3.3 provides industry unit shipments and industry dollar sales of clothes washers for the twelve year period 1987-1998.

Table 3.3 Industry Unit Shipments ³

Year	Shipments (Domestic+ Exports) (in 000's)	Estimated Industry Dollar Sales (Manufacturer dollar value in \$mil)	Shipments (Exports) (in 000's)
1987	5,998	-	247.6
1988	6,190	-	403.3
1989	6,252	-	385.3
1990	6,192	1,175.2	601.2
1991	6,197	1,783.5	692.7
1992	6,515	1,898.0	760.8
1993	6,793	1,986.1	769.7
1994	7,035	2,106.3	894.2
1995	6,901	2,090.2	824.6
1996	7,129	2,049.0	917.6
1997	6,326*	2,286.2	
1998	6,835*	2,151.4**	
1999	7,313*	2,276.8**	

*Domestic shipments only

**Domestic dollar sales only

In recent years sales of horizontal axis washers have been increasing. Traditionally horizontal axis machines have accounted for no more than 1 or 2 percent market share. Recent publically available data shows a horizontal axis market share of 6.6% (see Table 3.4).⁶ These data may not include all major retailers and therefore has a margin of error. In the last several years sales have picked up due to U.S. companies entering the horizontal axis market. High efficiency washer sales have been encouraged by regional rebate programs often combined with a rating system developed by the Consortium for Energy Efficiency (CEE). Other voluntary programs such as the The Energy Star program also promote high efficiency washers, encouraging the sales of resource efficient clothes washers.⁷ Major U.S. manufacturers offering H-axis machines at the time of this TSD (August 2000) are as follows: Maytag, Electrolux (Frigidaire), and General Electric. Goodman Manufacturing (Amana) also had a horizontal axis machine on the market which at the time this document was written was not in production. Whirlpool recently introduced an energy efficient vertical axis (V-axis) machine on the market. General Electric offers a horizontal axis machine made by another manufacturer.

Table 3.4 Washer Shipments by Access

Access	1998 ⁸	1999 ⁶
Top Load/ Vertical	93.9%	93.4%
Front Load/ Horizontal	6.1%	6.6%

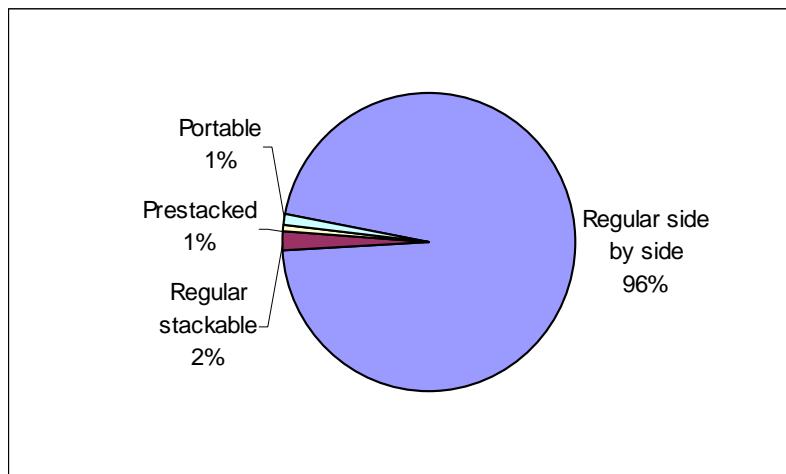


Figure 3.1 Washer Market Share by Type, 1998

Source: Statistical Survey and Report, *Dealerscope*, June, 1999.⁸

3.5 RETAILERS

Distributors are virtually non-existent in this market. Manufacturers deal directly with retail outlets or buying groups formed by smaller appliance stores (see Table 3.5).⁹

Table 3.5 Washer Sales by Type of Outlet

Outlet	1997 Market Share ⁸	1998 Market Share ¹⁰
Mass Merchandiser	32.6	35.3
Appliance Store	28.8	21.0
CE Superstore	10.4	12.2
Department Store	7.9	9.3
Furniture Store	5.0	1.8
Discount Dept. Store	3.7	5.1
Home Center	3.7	5.9
Hardware Store	1.1	-
Home Builder	1.0	3.9
Warehouse Club	1.0	3.2
Kitchen Remodeler	0.2	-
Catalog Showroom	0.1	-
Landlord	0.1	-
Mail Order/Direct	0.1	-
Other	4.3	2.3

3.6 PRICE DISTRIBUTION

Table 3.6 lists the clothes washer unit sales in the U.S. by price range. Clothes washer retail or consumer prices are required for conducting the life-cycle-cost analysis and manufacturer prices are required for identifying the financial impact of standards on manufacturers. Chapter 6 of this document provides detailed information on both retail and manufacturer prices and markups.

Table 3.6 Clothes Washer Unit Sales by Price Range ¹¹

Price Range	Market Share 1997
Under \$200	1.2%
\$200-299	6.3%
\$300-399	38.2%
\$400-499	31.7%
\$500-599	13.7%
\$600-699	5.6%
\$700-799	0.7%
\$800 and above	2.6%

Note: Neptune, the Maytag H-axis washer, is not covered in this table.

Tables 3.7 and 3.8 provide the producer and consumer price index for laundry equipment. Average producer and consumer prices for laundry equipment rose less steeply than for other commodities.

Table 3.7 Producer Price Index, Annual Average (1982=100)

Year	All commodities	Laundry equipment
1967	33.4	48.5
1972	39.8	52.2
1977	64.9	73.1
1982	100	100
1987	102.8	107.7
1988	106.9	107.6
1989	112.2	109.7
1990	116.3	112.4
1991	116.5	112.5
1992	117.2	111
1993	118.9	110.5
1994	120.4	109.6
1995	124.7	108.8
1996	127.7	109.5
1997	127.6	105.4
1998	124.4	104.2

Source: U.S. Bureau of Labor Statistics, *Producer Price Index*¹²

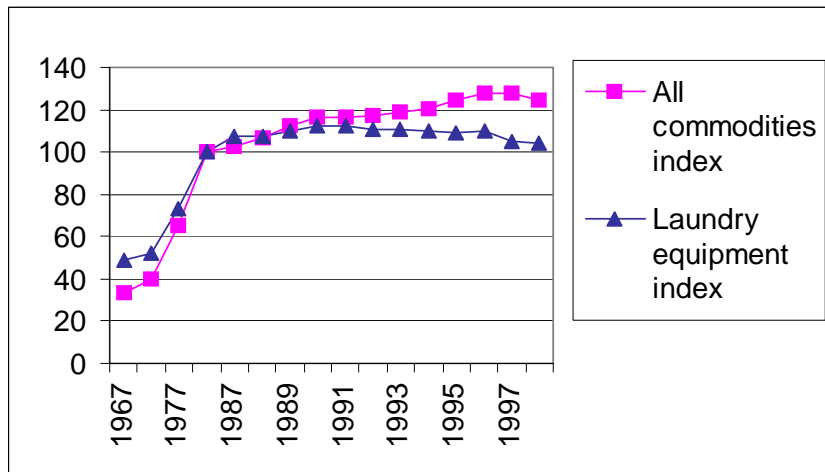
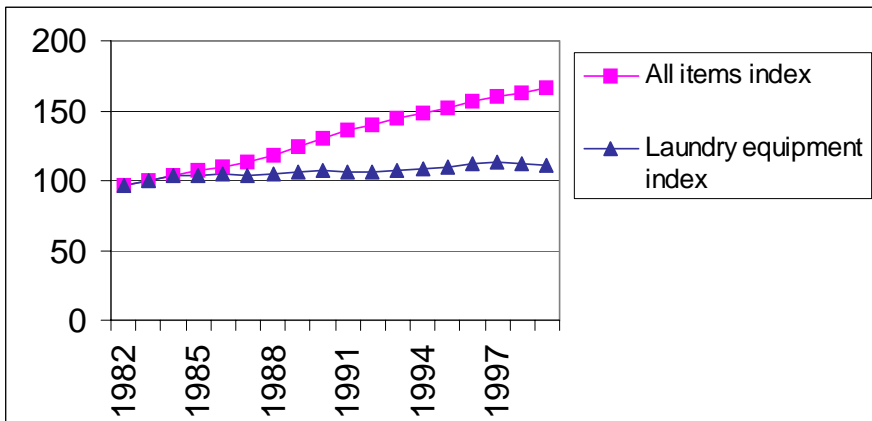


Figure 3.2 Producer Price Index for All Commodities and for Laundry Equipment, 1967-1998

**Table 3.8 Consumer Price Index (All Urban Consumers); Annual Average
(1982-1984 = 100)**

Year	All items	Laundry Equipment
1982	96.5	96.3
1983	99.6	100.6
1984	103.9	103.2
1985	107.6	104.0
1986	109.6	104.8
1987	113.6	104.1
1988	118.3	105.1
1989	124.0	105.9
1990	130.7	107.2
1991	136.2	106.2
1992	140.3	105.8
1993	144.5	106.7
1994	148.2	109.0
1995	152.4	109.6
1996	156.9	111.9
1997	160.5	113.1
1998	163.0	112.5
1999	166.6	110.5

Source: U.S. Bureau of Labor Statistics, *Consumer Price Index*¹³



**Figure 3.3 Consumer Price Index for All Items and for
Laundry Equipment, 1982-1999**

3.7 PRODUCT CHARACTERISTICS

Clothes washers of different capacities and configurations are sold in the market. A survey by Elrick and Lavidge for the year 1995, provided information in Table 3.9 below.

Table 3.9 Washer Characteristics (1995)¹⁴

Features	Units Sold	Average Price
Type		
Regular Side by Side	97.6%	\$373
Door		
Top Load	99.9%	\$384
Front Load	0.1%	\$668
Capacity		
Large Load (15-18 lbs.)	35.6%	\$355
Extra Large Load (19+ lbs.)	64.1%	\$401

Figure 3.4 shows market shares by capacity, and Figure 3.5 shows market share by number of washer speeds.

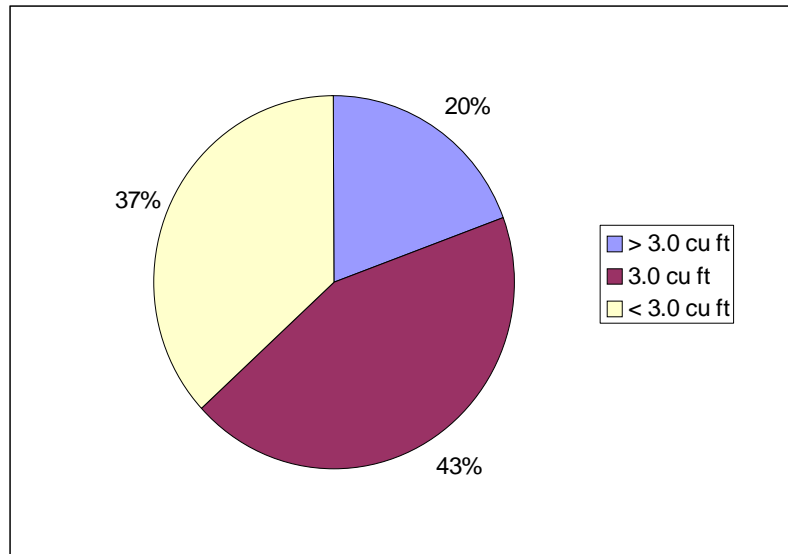


Figure 3.4 Washing Machine Market Share by Cubic Capacity

Source: Statistical Survey and Report, *Dealerscope*, June 2000[, 2000 #405]

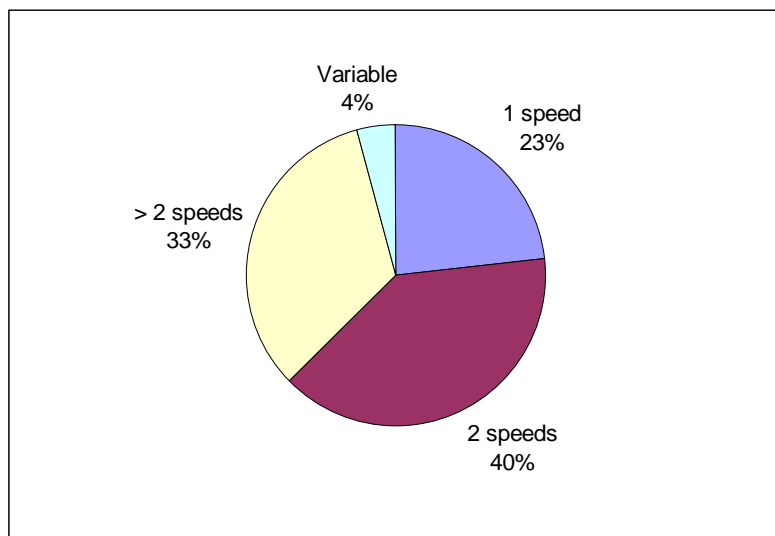


Figure 3.5 Washing Machine Market Shares by Speed

Source: Statistical Survey and Report, *Dealerscope*, June 2000[, 2000 #405]

Table 3.10 provides the brand names used by the different manufacturers and the price level for a given brand. Table 3.11 shows the market shares by brand. Manufacturers also build dryers, usually marketed as a set washer with matching dryer. See Appendix A for a list of manufacturers and addresses.

Table 3.10 Brand Names, Price Level and Market Share of Major Manufacturers¹⁵

Parent Company	Brand	Price Level
Whirlpool	Sears/Kenmore	Varied
	Whirlpool	Mid-priced
	Roper	Value
	Kitchen Aid	High
Maytag	Maytag	High
	Admiral	Mid-low
	Magic Chef	Value
	Norge/Crosley	Value
General Electric	General Electric	High/Mid
	Hot Point	Value
	RCA	Mid
Electrolux	Frigidaire	Mid-High
	White Westinghouse	Value
	Kelvinator	Value
	Tappan	Mid
	Gibson	Value
Raytheon*	Amana	Mid
	Speed Queen	Value

EPRI sources: Statistical Survey and Report, *DealerScope*, May 1996, p. 60; Quality (i.e., price) levels taken from Smith Barney Whirlpool/Maytag Company Report 1/17/96.

*Raytheon sold the Amana brand to Goodman Holdings, Inc. and licences the SpeedQueen brand to them.

Table 3.11 Washer Market Share by Brand

Brand	1997 Market Share ¹⁰	1998 Market Share ¹⁶	1999 Market Share ¹⁷
Sears/Kenmore	25.6	26.8	31.0
Whirlpool	20.4	20.7	19.5
Maytag	17.1	20.4	19.2
General Electric	12.4	12.3	11.6
Amana	4.5	4.0	7.1
Frigidaire	4.3	5.9	6.9
Roper	3.3	3.1	-
Hotpoint	2.8	2.1	1.2
White-Westinghouse	2.1	1.9	1.6
Admiral	1.3	1.0	-
Speed Queen	1.2	-	-
Gibson	1.0	-	-
Kitchen Aid	1.0	1.0	-
Magic Chef	0.5	-	1.1
RCA	0.5	-	-
Montgomery Ward	0.4	-	-
Kelvinator	0.3	-	-
Asko	0.2	-	-
Crosley	0.2	-	-
Other	1.9	0.8	0.8

3.8 MARKET SATURATION

The saturation of clothes washers varies with the type of housing and income level. The 1990 U.S. Census gives a clothes washer penetration of 76%. *Appliance Magazine* gives a saturation for 1998 of 79.8%.¹⁸ The saturation rates for 1987 through 1998 are shown in Figure 3.6.¹⁶

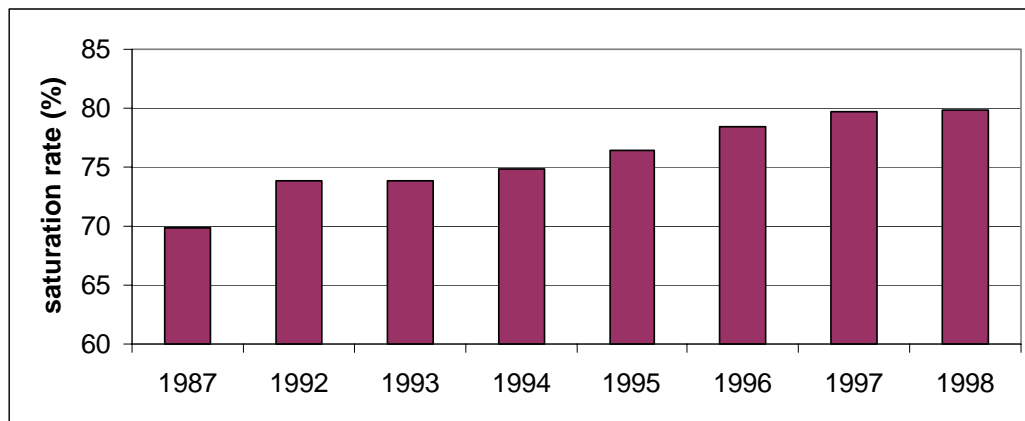


Figure 3.6 Clothes Washer Saturation Rates (% of Household Units), 1987-1998

3.9 VOLUNTARY PROGRAMS (TO INCREASE WASHER EFFICIENCY / PROMOTE HORIZONTAL AXIS MACHINES)

The Department researched voluntary programs. Research included regional programs that encouraged the buying of high efficiency clothes washers through rebates, education and demonstration projects. National efforts such as Energy Star are also summarized. The entire report is located in Appendix I.

3.10 FUEL USE

Although clothes washers are all electric powered, most of the energy used by clothes washers is for heating water. This for the most part is either gas or electric water heaters. The reduction in drying clothes due to greater moisture extraction in the clothes washer is also a contribution to clothes washer energy savings and is therefore also shown in the chart below. Figure 3.7 shows the distribution of water heater and dryer fuel for households having a clothes washer and is taken from RECS which uses data collected in 1993.¹⁹ The data are also shown in Table 3.12. The data presented is for households having a clothes washer. Approximately 53% of households having a washer use natural gas to heat water and 39% use electricity. Approximately 73% of households have a electric dryer and 18% have a gas dryer.

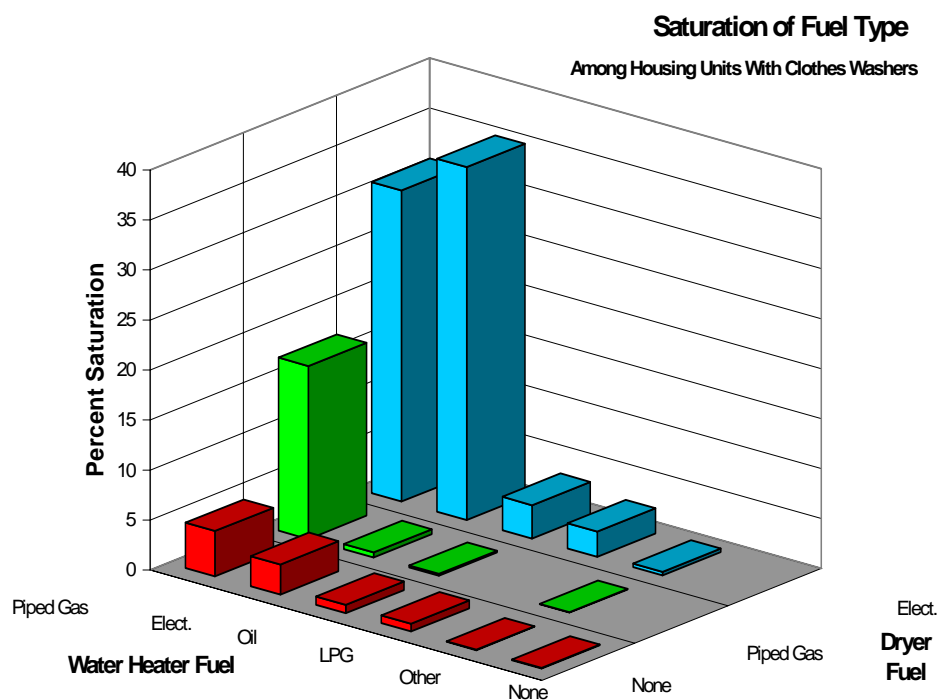


Figure 3.7 Water Heater and Dryer Fuel Use

Table 3.12 Market Saturation by Fuel Type Among Housing Units with Clothes Washers

Water Heater Fuel		Percent Dryer Fuel		
Type	Percent	Electricity	Gas	None
Piped gas	52.97	31.14	17.3	4.53
Electricity	38.81	35.3	0.49	3.03
Fuel oil	4.36	3.33	0.18	0.85
LPG	3.32	2.53	-	0.79
Other	0.46	0.36	0.05	0.04
None	0.08	0.01	-	0.07

3.11. INDUSTRY COST STRUCTURE

The washing machine industry cost structure was developed from publicly available information from the *Census of Manufactures*,²⁰(Tables 3.13 and 3.14) and the Securities and Exchange Commission (SEC) 10-K reports filed by publicly owned manufacturers (summarized in Table 3.15).

Table 3.13 Employment and Earnings

Year	Production workers ('000)	All employees ('000)	Payroll for all employees (million dollars)
1997	12.9	14.8	480
1992	12.1	14.2	423.1
1987	14.1	16.7	465.8
1982	13.4	16.5	335.4
1977	15.9	19.4	262.4

Source: U.S. Census of Manufactures 1992, 1997⁵

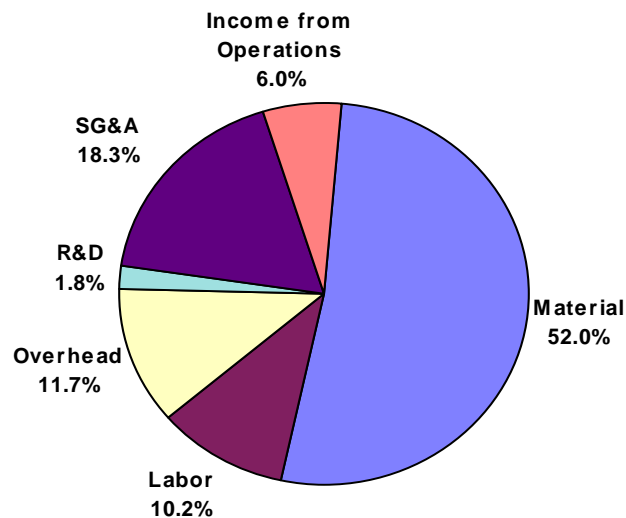
Table 3.14 Information from the 1992 and 1997 Census of Manufactures

Census Year	Cost of Materials as a percent of value of shipments (percent)	Cost of Payroll for production workers as a percent of value of shipments (percent)	Cost of Total Payroll (production+admin.) as a percent of value of shipments (percent)
1997	55.9	10.6	12.9
1992	52	10.2	12.7
1987	54	12.3	15.3
1982	53	12.3	15.8

Table 3.15 Summary of SEC 10-K Reports of Appliance Manufacturers

Appliance Manufacturers	1992-1996	% of Sales
Net Sales	\$52,381.7	100%
Cost of Sales	\$38,877.8	74.2%
Selling, General & Admin.	\$9,574.0	18.3%
Research & Development	\$953.7	1.8%
Depreciation	\$1816.3	3.5%
Amortization, Tooling	\$0.0	0.0%
Amortization, Intangibles	\$154.8	0.3%
Income from Cont. Operations	\$3143.0	6.0%
Income before Interest, Taxes, Extr. Items	\$2952.8	5.6%
Net Income	\$1094.2	2.1%
Capital Expenditures	\$2,368.0	4.4%

The resulting cost structure is shown in Figure 3.8. This a composite for the industry as a whole; no single firm may have these results. In developing the cost structure for the washing machine industry, it is assumed that the washing machine industry is a microcosm of the total major appliance industry.

**Figure 3.8 Washing Machine Industry Cost Structure as a Percentage of Revenues**

A detailed financial analysis of the clothes washer industry to identify key financial inputs like cost of capital, working capital, depreciation, capital expenditures, etc. is presented in Chapter 11 of this document.

3.12 INVENTORY LEVELS AND CAPACITY UTILIZATION RATES

Table 3.16 shows the year-end inventory for the washer industry. Table 3.17 shows the production capacity utilization rate.

Table 3.16 End-of-year Inventory, 1977-1997

Year	End-of-year Inventory (Million Dollars)	End-of-year Inventory as a Percent of Value of Shipments (%)
1997	368.1	9.9
1996	346.9	8.2
1995	328	7.9
1994	341.6	7.4
1993	338.6	8.7
1992	264.4	7.9
1991	326	10.2
1990	393.8	12.2
1989	367.3	11.8
1988	350.6	11.2
1987	342.9	11.3
1986	325.5	10.6
1985	306.6	10.8
1984	323.2	11.9
1983	313.9	13.2
1982	286.4	13.5
1981	173.4	7.7
1980	170.1	7.9
1979	185.7	8.4
1978	157.7	8.1
1977	170.6	9.5

Source: U.S. Bureau of the Census, *Census of Manufactures*, 1992, 1997⁵; *Annual Survey of Manufacturers*, 1993, 1994, 1995, 1996²¹

Table 3.17 Full Production Capacity Utilization Rates* (%)

1997	1996	1995	1994	1993	1992	1991	1990
80	81	83	89	n/a	n/a	n/a	78

*Ratio of the actual value of production to the level of production at full production capability

Source: U.S. Bureau of the Census, *Survey of Plant Capacity*, 1997, 1996, 1994²²

3.13 TECHNOLOGY ASSESSMENT

The efficiency of some clothes washers currently on the market have been improved by adding design options such as:

- adaptive fill control,
- temperature sensing to set wash temperatures more precisely and to lower the water temperature (to allow lower water temperatures),
- features that promote greater moisture removal for the final spin cycle; such as higher spin speeds, longer spin speeds and
- horizontal axis designs (also referred to as tumble wash designs).

More detail on clothes washer technology is available in two DOE reports: *Draft Report on the Preliminary Engineering Analysis for Clothes Washers*²³ and *Draft Report on Design Options for Clothes Washers*.²⁴

3.14 ENERGY EFFICIENCY

The test procedure on which this rulemaking is based will only take effect when a new standard is enacted. Therefore, publically available efficiency data are still based on the current test procedure referred to as Appendix J. In order to get an idea of current efficiencies on the market using the future test procedure metric of J1 and how they correlate to current test procedure ratings using EF, thirteen clothes washers were tested according to the new test procedure Appendix J1. A summary of the washers tested is shown in Table 3.18. Test results for Appendix J and J1 are shown in Table 3.19.

Table 3.18 Product Characteristics of Clothes Washer Tested

Clothes Washer	Type	Capacity (cu. ft.)	Warm Rinse
A	V-axis	2.42	yes
B	H-axis	2.90	yes
C	V-axis	2.78	yes
D	V-axis	3.26	no
E	V-axis	3.03	no
F	H-axis	2.54	yes
G	V-axis	3.00	yes
H	V-axis	3.02	no
I	V-axis	3.00	yes
J	V-axis	3.20	no
K	V-axis	3.20	yes
L	V-axis	3.00	no
M	V-axis	3.00	no

Table 3.19 Summary of Appendix J and J1 Test Results

Clothes Washer	J Results		J1 Results			
	EF (cu. ft./kWh) per cycle	% Efficient over NAECA Minimum (EF=1.18)	MEF (cu. ft./kWh) per cycle	% Efficient over AHAM Baseline (MEF=0.817)	WCF (J1)	RMC (J1)
A	1.161	0.0	0.819	0.2	12.88	59.7
B	2.339	49.6	1.594	48.7	8.00	49.6
C	1.166	0.0	0.876	6.7	12.02	54.6
D	1.326	11.0	1.148	28.8	11.16	54.8
E	1.149	0.0	1.050	22.2	11.96	54.3
F	3.929	70.0	1.451	43.7	9.46	55.5
G	1.141	0.0	0.870	6.1	13.43	61.4
H	NT		0.966	15.4	8.13	52.1
I*	2.650	55.5	1.320	38.1	8.40	51.3
J*	1.440	18.1	1.080	24.4	11.30	63.9
K	1.500	21.3	0.864	5.4	11.97	59.8
L	NT		1.310	37.6	12.81	47.8
M	NT		1.780	54.1	8.87	41.9

Source: Intertek Testing Services^{25, 26, 27, 28}

- J1 results not re-tested using cloth correction factor
- NT Not Tested

3.15 DETERMINING MEF VALUE FOR VERTICAL AXIS COMPACT CLOTHES WASHERS

Due to the small market share of washers under 1.6 cu. ft., a separate analysis was not conducted for this product class. Since after the clothes washer rulemaking a new test procedure and metric will become effective, a way to determine the future Modified Energy Factor (MEF) is needed. The current minimum efficiency standard level, expressed as EF, is based on DOE Test Procedure Appendix J; the new efficiency standards, expressed as MEF, will be based on DOE test procedure Appendix J1. The new test procedure will become effective after the proposed efficiency standard is enacted.

There is no simple conversion factor to convert from the Appendix J, EF to the Appendix J1, MEF. Therefore, a spreadsheet with both the Appendix J and Appendix J1 test procedure versions has been constructed. Identical parameters can be inputted into the spreadsheet along with additional information needed for Appendix J1. This allows calculated results for each test procedure to be compared. The main additional information required to determine an MEF is the remaining moisture content (RMC) of the test cloth after the final spin. When actual test data is unknown or if generic results are desired, inputs can be based on estimates or rules of thumb.

Table 3.20 shows estimated MEF values for a 1.59 cu. ft. and a 1.96 cu. ft. capacity clothes washer. The Energy Factors used were based on the following:

- 0.90 current minimum EF for top-loading compact washers (compact means <1.6 cu.ft.)
- 1.18 current minimum EF for standard capacity washers
- 1.20 EF of an existing model washer with a 1.96 cu. ft. capacity
- 1.32 EF of an existing model washer with a 1.96 cu. ft. capacity

Table 3.20 Estimated MEF Values for 1.56 and 1.96 Cubic Foot Clothes Washers

Basket Capacity Cu. Ft.	EF (Energy Factor)*	Max. Gallons Fill	Estimated MEF	
			No warm rinse	With warm rinse
1.59	0.90	15.0	0.75	0.65
	0.99	13.3	0.79	0.69
1.96	0.90	19.0	0.76	0.66
	1.18	13.9	0.86	0.76
	1.20	13.6	0.86	0.77
	1.32	12.1	0.90	0.81

* Assuming a Alt. II or Alt. III cycle configuration

Additional detail on the spreadsheets, assumptions and results are presented in Appendix B.

REFERENCES

1. Matimore, M. K., Manager, Market Data, AHAM, *personal communication*. Conversation with Peter Biermayer, LBNL. July 7, 1997.
2. 1997: Slow Growth Ahead. *Appliance Magazine*, 1997. 54(1): p. 38
3. Association of Home Appliance Manufacturers, *1997 Major Appliance Industry Fact Book*. 1998: Chicago, IL.
4. The Share-of-Market Picture. *Appliance Magazine*, September, various years
5. U.S. Department of Commerce - Bureau of the Census, *Census of Manufactures*, various years. Washington, DC.
6. Statistical Survey and Report, data source: NBD INTELECT. *Dealerscope*, 2000. 42(6): p. 19 (June)
7. *Revised Draft Report on Consumer Research for Clothes Washers, DOE Comment 85, Docket No. EE-RM-94403*, April 3, 1998.
8. Statistical Survey and Report, data source: NBD INTELECT. *Dealerscope*, 1999. 41(6): p. 28 (June)
9. EPRI-The High-Efficiency Laundry Metering and Marketing Analysis Project (THELMA), *Distribution System Analysis*.
10. Statistical Survey and Report, data source: Dealerscope Consensus Survey. *Dealerscope*, 1998. 40(6): p. 23(June)
11. Statistical Survey and Report, data source: NBD INTELECT. *Dealerscope*, 1998. 40(6): p. 22 (June)
12. U.S. Department of Labor-Bureau of Labor Statistics, *Producer Price Index*. <<http://stats.bls.gov/ppihome.htm>>
13. U.S. Department of Labor - Bureau of Labor Statistics, *Consumer Price Index-All Urban Consumers*, <<ftp://ftp.bls.gov/pub/special.requests/cpi/cpiat.tx>>
14. Elrick and Lavidge, Washer Sales Percentage of Units Sold by Features, *personal communication*. One page memo. 1996.
15. EPRI, *Marketing Strategies for Horizontal Axis Washers*, December, 1996. Boston, MA. Prepared by Dove Associates, Inc. pp. 2-8. Report No. EPRI TR-107612.

16. Statistical Survey and Report, data source: Dealerscope Consensus Survey. *Dealerscope*, 1999. 41(6): p. 28(June)
17. Statistical Survey and Report, data source: Dealerscope Consensus Survey. *Dealerscope*, 2000. 42(6): p. 19
18. The Saturation Picture. *Appliance Magazine*, 1999. 56(9): p. 80
19. U.S. Department of Energy - Energy Information Administration, *Residential Energy Consumption Survey: Household Energy Consumption and Expenditures 1993*, October, 1995. Washington, DC. Report No. DOE/EIA-0321(93).
20. U.S. Department of Commerce - Bureau of the Census, *1992 Census of Manufactures*, 1995. Washington, DC. Report No. MC92-I-36B.
21. U.S. Department of Commerce - Bureau of the Census, *Annual Survey of Manufacturers*, various years. Washington, DC. <<http://www.census.gov/econ/www/ma0300.html>>
22. U.S. Department of Commerce - Bureau of the Census, *Survey of Plant Capacity*, various years. Washington, DC. <<http://www.census.gov/prod/www/abs/plant.html>>
23. *Draft Report on the Preliminary Engineering Analysis for Clothes Washers, DOE Comment 55B, Docket No. EE_RM_94-403*, November, 1996.
24. *Draft Report on Design Options for Clothes Washers, DOE Comment 55C, Docket No. EE-RM-94-403*, November 15, 1996.
25. Intertek Testing Services, *ITS Report J98004015-001(April 1998)*, 1998. Cortland, NY.
26. Intertek Testing Services, *ITS Report J98029012-001(October 1998)*, 1998. Cortland, NY.
27. Intertek Testing Services, *ITS Report J20006542-001(March 2000)*, 2000. Cortland, NY.
28. Intertek Testing Services, *ITS Report J20008389-001(May 2000)*, 2000. Cortland, NY.